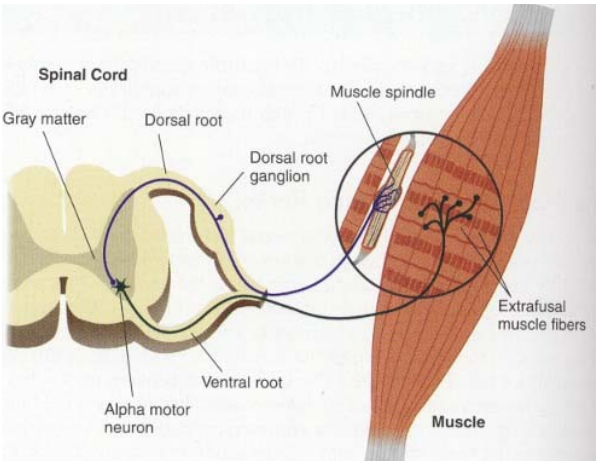
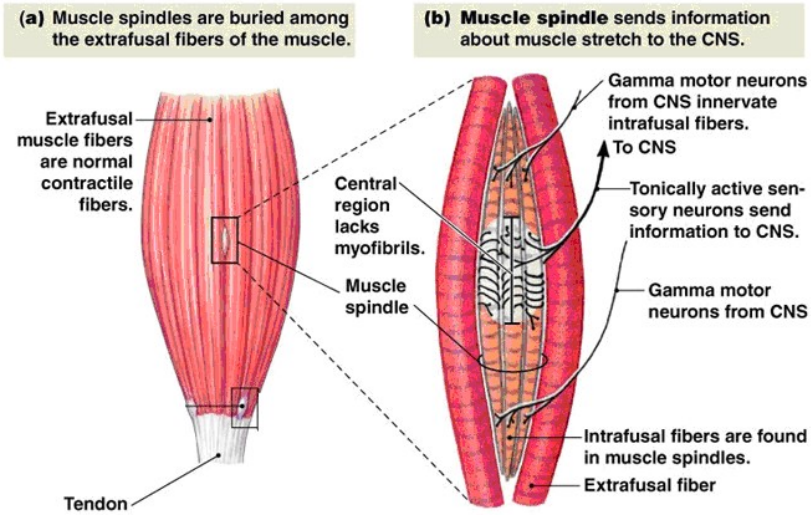
Stretch Reflex

Stretch Reflex (**muscle spindle reflex)** is the reflex muscle contraction when the muscle (with intact nerve supply) is stretched.

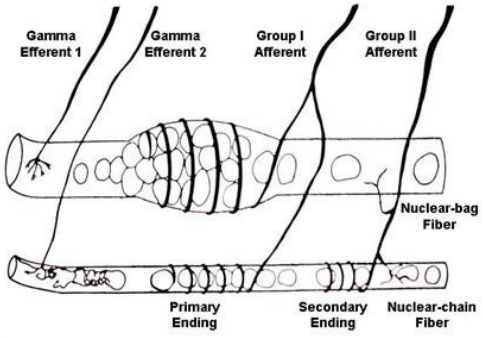


The receptor is the muscle spindle



Muscle spindles are encapsulated *mechanoreceptors* located in the *fleshy* part of skeletal muscles. Each contains 3-10 *intrafusal muscle fibers* that are smaller and less striated than the ordinary extrafusal muscle fibers. These intrafusal muscle fibers are of two types:

1. **Nuclear bag:** Its central (receptor) area is dilated like a bag and contains many nuclei. Its peripheral parts (the two ends) are striated and contractile.
2. **Nuclear chain**: The central (receptor) part is thinner than nuclear bag and contains many nuclei, while



the peripheral parts are contractile.

Innervation of the muscle spindle

1. **Afferent nerve** fibers are two types:

a- Primary Afferents **(Annulospiral)***:*

arise from **both** nuclear bag & chain making spirals around the receptor area.

Type of afferent nerve fiber: **A-**α (rapid rate of conduction) = Ia which is rapidly adapting.

They respond to **both** the change in lengh and the rate of this change.

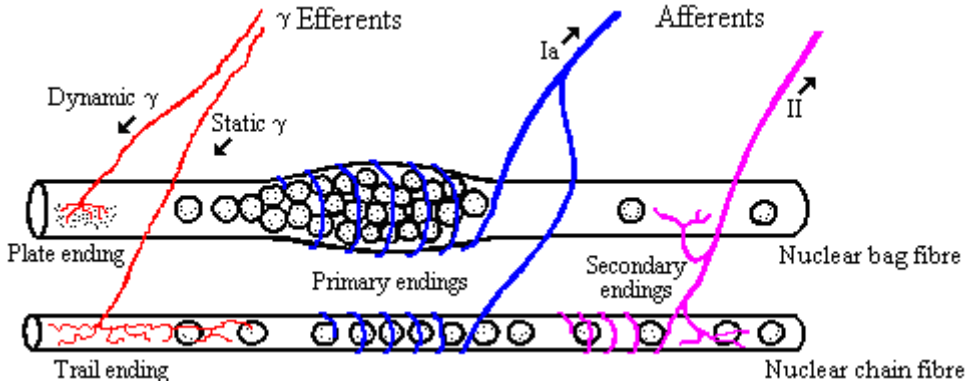
b. Secondary afferents **(flower spray)***:* arise **mainly** from the nuclear chain.

Type of nerve fiber: **A-**β (slower rate of conduction).

Type of afferent: II which is relatively slowly adapting.

They respond to maintained change in length **mainly**.

2. **Efferent Innervation:** The spindles have a motor nerve supply. These efferent fibers are called *gamma-efferents* (4 μ thick & rate of conduction 40 m/sec) and they supply the outer parts of the intrafusal fibers (both nuclear bag and nuclear chain).



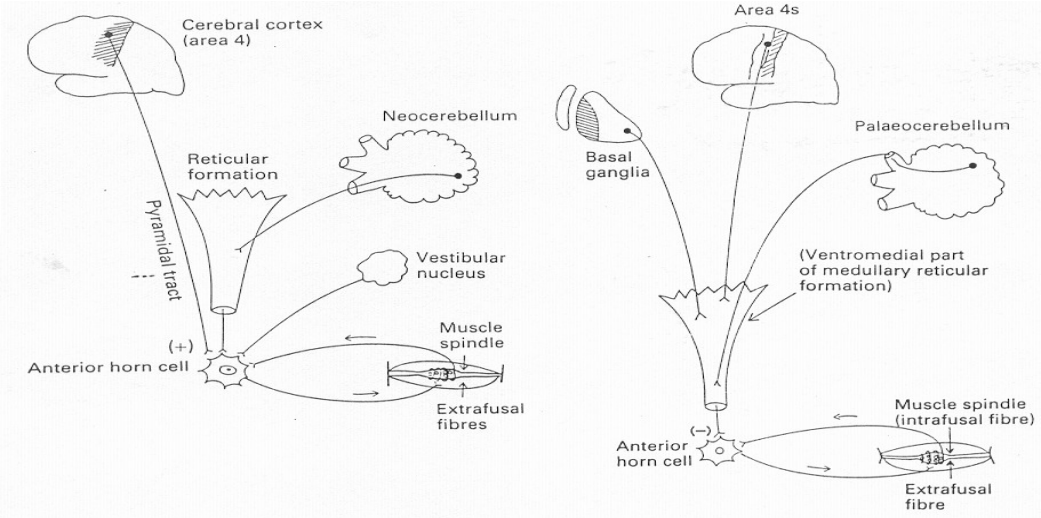
The □-efferents recieves supraspinal facilitatory and inhibitory impulses

Facilitatory Supraspinal Centers

- Motor area 4
- Facilitatory reticular formation
- Neocerebellum
- Vestibular nucleus

Inhibitory Supraspinal Centers

- Suppressor motor areas; 4 S
- Inhibitory reticular formation
- Paleocerebellum
- Red nucleus & basal ganglia



Also, γ efferent discharge is increased by:

- Anxiety.
- Painful stimulation of the skin.
- Hooking the hands and clenching of the teeth (reinforcement).

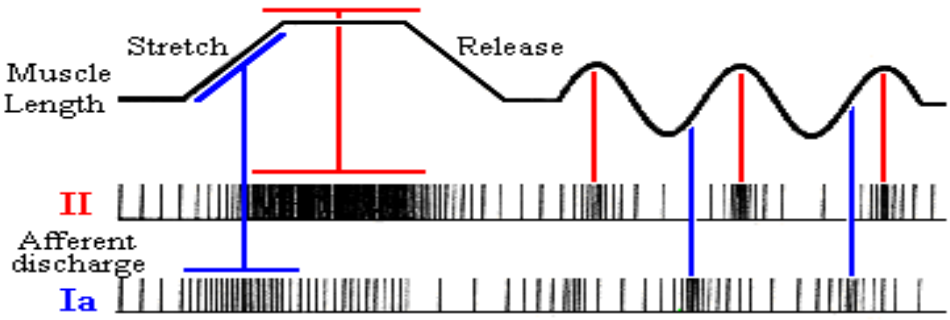
Stimulation of the muscle spindles can be done by two ways:

1. Passive stretch of the whole muscle.
2. γ-efferents cause contraction of the peripheral parts of the intrafusal fibers.

Both ways stretch the midportions of the spindle and excite the receptor area.

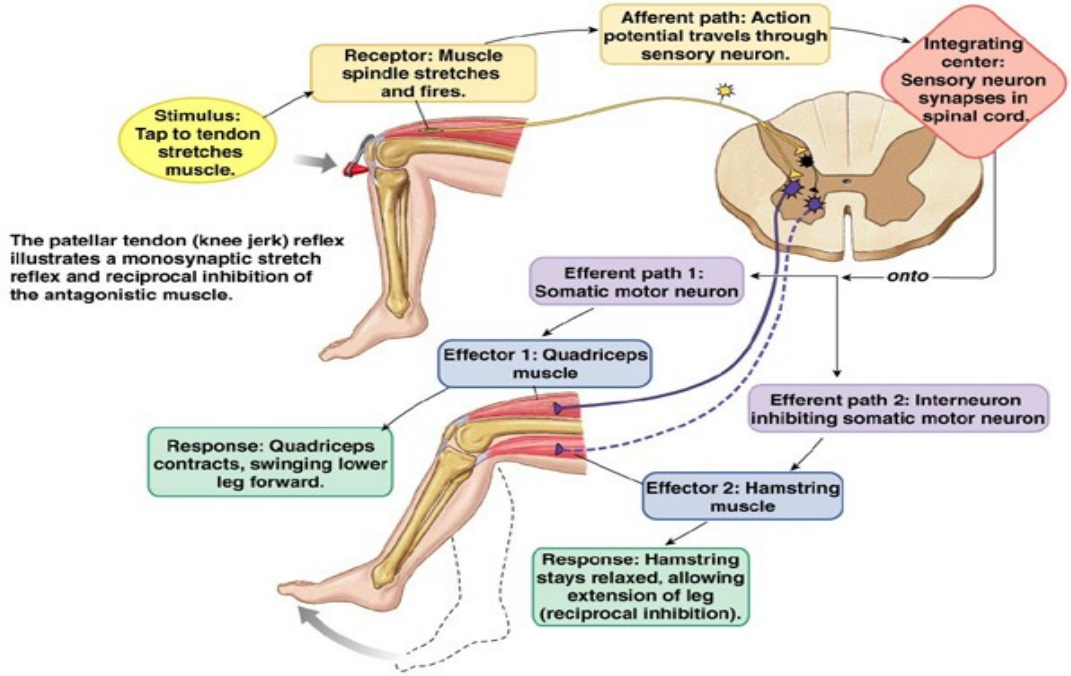
Responses to muscle stretch include:

1. ***Dynamic response***: *rapid* (fraction of a second) stretch of the spindles (e.g. tapping the tendon by a hammer) stimulates nuclear bag *mainly* so impulses pass via *primary* afferents *only* causing **muscle contraction**. So, the stretch of the spindles decreases leading to **muscle relaxation**. This is the basis of tendon jerks.
2. ***Static response:*** *slow maintained* stretch of the spindles stimulates both the *primary* and the *secondary* afferents causing maintained muscle contraction. This is the basis of muscle tone.

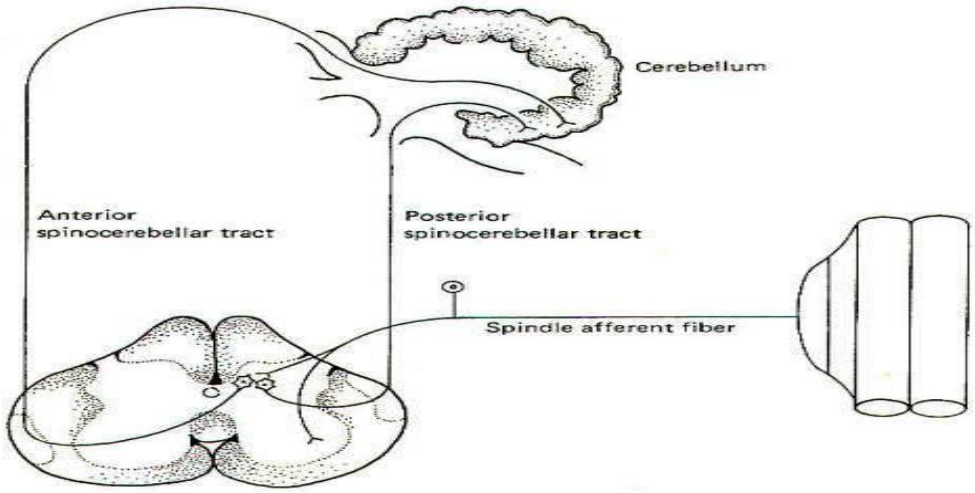


Types of Stretch Reflex

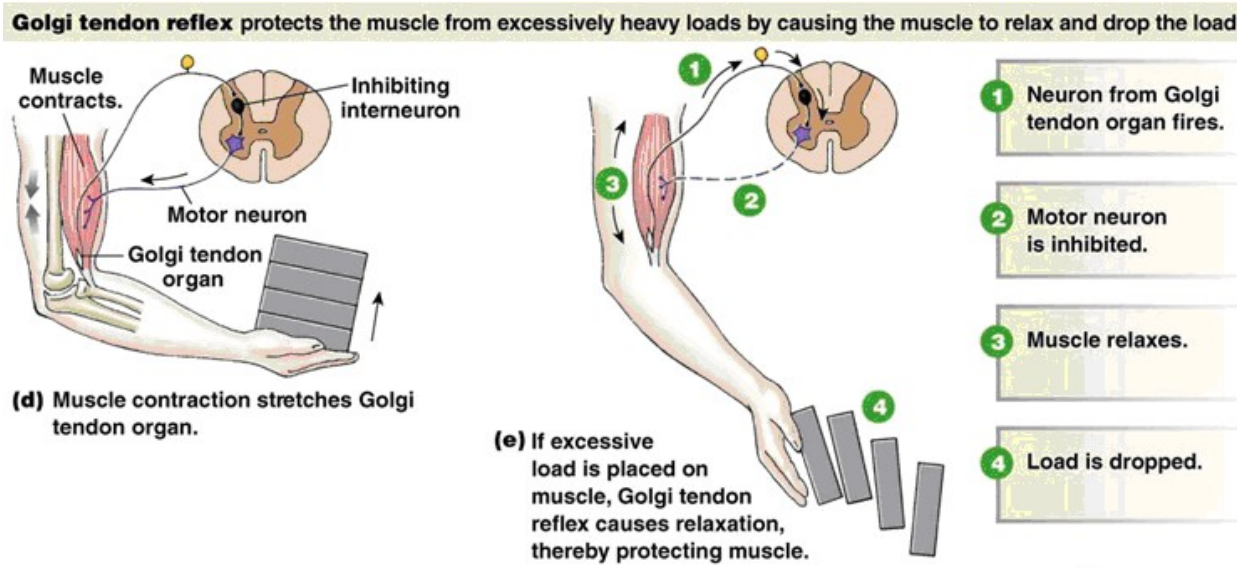
1. **Static Stretch Reflex:** slow *maintained* muscle stretch leads to stimulation of *both* the primary and secondary afferents leading to *prolonged* contraction (muscle tone).
2. **Dynamic Stretch Reflex**: *rapid stretching* of the muscle stimulates the *primary* afferents mainly leading to *rapid* muscle contraction (tendon jerk).



3. **Negative Stretch Reflex**: shortening of the muscle leads to its relaxation.
4. **Cerebellar stretch reflex**: long loop reflex, it could be facilitatory or inhibitory to γ efferents. Sensory information is sent to cerebellum about position, stretch and legth of the muscle, so cerebellum will be able to correct abnormal range of movements through its connection with the cerebral cortex.



5. **Inverse Stretch Reflex:** overstretch or very strong muscle contraction will increase the tension on the tendon leading to stimulation of *Golgi tendon organ* and **muscle relaxation** follows.



Functions of the Stretch Reflex

1. **Muscle tone** is a state of partial (subtetanic) continuous contraction of skeletal muscles during rest. It is the static type of stretch reflex.

It is present in **all skeletal muscles** but more in ***antigravity muscles*** (flexors of upper limbs, extensors of lower limbs, extensors of neck and back, anterior abdominal wall, and elevators of the jaw). The functions of muscle tone are:

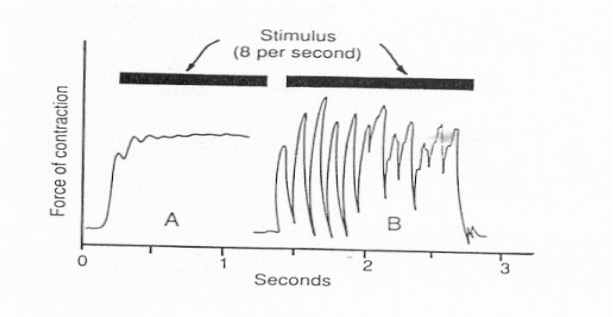
a) keeping the erect posture of the body by contraction of the antigravity muscles
b) Help venous and lymph drainage
c) Keep the body temperature
d) Prevent abdominal visceral ptosis

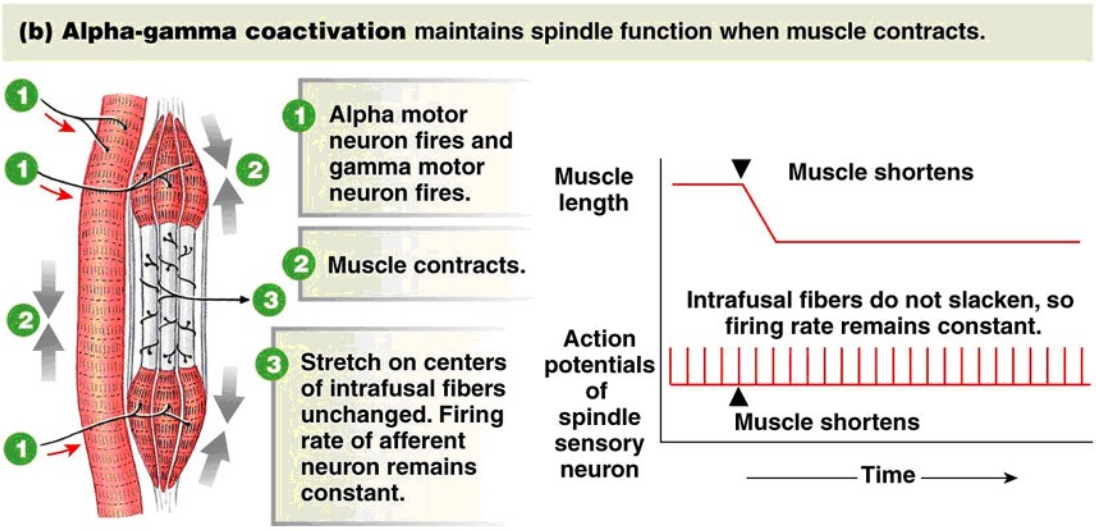
2. **Damping function [signal averaging]:** it prevents oscillations and jerkness in movements leading to smooth muscle contractions.

• **Mechanism:** signals coming from the higher centers to the muscles are of variable intesities. This may cause a jerky muscle contraction. But, the **muscle spindle reflex** and □□□ **linkage (coactivation)** causes □-efferents discharge to increase and decrease to damp these oscillations *(signal averaging by stimulation of agonist or antagonist muscles)*.

(A) oscillations are buffered *(smoothening of muscle contraction)*.

(B) cutting the dorsal roots to interrupt the stretch reflex arc leads to oscillations.





3- Increasing the power of muscle contraction (Servo-assisst function in voluntary movements): this occur by

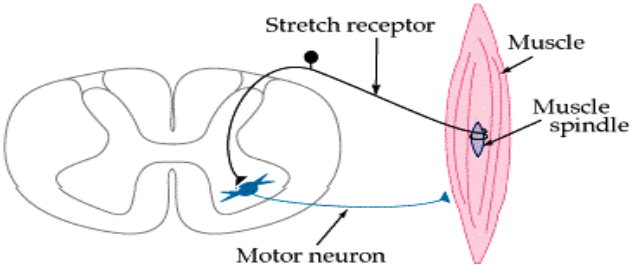
- *Enable* the muscle to contract against load (during lifting heavy objects). The load stretches the muscle leading to more powerful contraction (**Load Reflex**)
- *Fix* various parts of the body in certain positions (especially against gravity) in order to do exact precise voluntary movements..

Mechanism: α-γ linkage (coactivation): supraspinal discharge cause both α and γ stimulation, leading to contraction of both intra- and extrafusal muscle fibers, consequently, increased γ- efferent discharge stimulates the spindles leading to increased power of contraction of extrafusal muscle fibers.

So when you add a load to the limb, muscle will be stretched, and **α-γ coactivation** will lead to powerfull contraction and limb will be able to hold different added loads. And every time load is added the limb return to its position.

Properties of the stretch reflex

1. It is monosynaptic i.e. *no interneurones* are present in the reflex arc, so, the synaptic delay is minimal (0.5 msec) and ther is **no** after discharge.



2. It is extremely localized to the stretched muscles only like the antigravity muscles.
3. the muscle tone does not show fatigue due to :

a- weak contraction.

b-There is continuous alternation between the contracting and relaxing fibers.

c-few muscle fibers are contracting (causing the tone) while the majority are relaxed.

4. It can be inhibited by:

a-Excessive tension on the tendons stimulating Golgi tendon organ.

b-Muscle contraction.

c-Stimulation of the antagonistic muscle (reciprocal innervation).

Tendon Jerks

It is the response of the skeletal muscles to sudden stretch produced by sharp strong tapping on their tendons using a hammer. This will elicit the **dynamic stretch reflex** resulting in rapid contraction and relaxation of the muscle i.e jerk.

* **Types:**

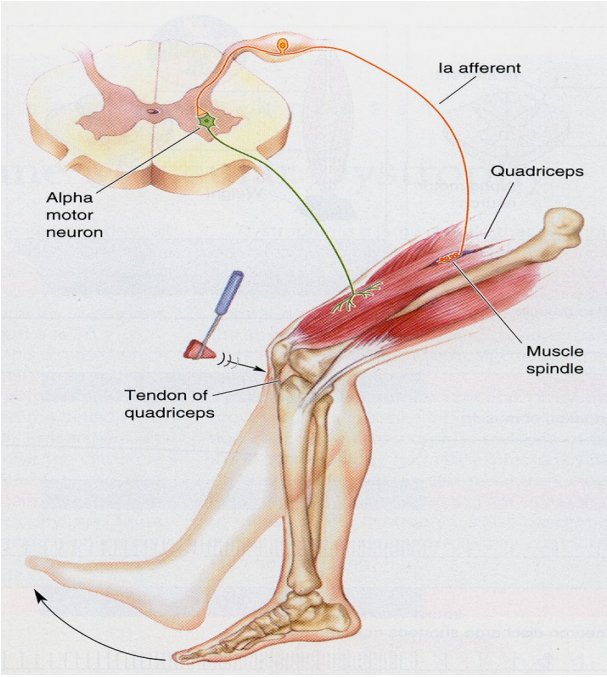
1**. Knee jerk (L 2, 3 & 4)**

2. Ankle jerk (S 1 & 2)

3. Biceps jerk (C 5 & 6)

4. Tricepes jerk (C 6 & 7)

- **Reinforcement of the tendon jerks:** It means increasing the jerks by facilitating the spinal centers. In the *lower limb* it can be achieved by grasping and pulling hands by maximal effort (Jendrassik's maneuver). While, facilitation of the *upper limb* jerks can be obtained by clenching the teeth. This leads to stimulation of γ-efferent and distraction of the patient's attention preventing any voluntary inhibition of the reflex.



Clinical abnormalities of the tendon jerks

Hyper reflexia or exaggeration tendon jerk

- UMNL
- Hyperthyroidism
- Tetany (low blood Ca^{++})
- Paleocerebellar lesion
- Anxiety

Hyporeflexia

- Sleep
- Coma
- Shock
- Anesthesia
- Myxdema

Arreflexia

- LMNL (lesion in the afferent, center or motor nerve)

Pendular jerks

- Neocerebellar lesion.
- Chorea (lesion is basal ganglia)
- Pure motor area 4 lesion.